EMERGENCY CONSERVATION WORK

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STAND-IMPROVEMENT MEASURES FOR SOUTHERN FORESTS

PREPARED BY THE
STAFF OF THE SOUTHERN FOREST EXPERIMENT STATION
UNITED STATES FOREST SERVICE

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INTRODUCTION

The purpose of this publication is to present information that will serve as a guide in operations to improve the growth and quality of forest stands in the South.[1] Because both silvicultural and economic conditions affecting southern forests vary widely, it is impracticable to set up recommendations sufficiently detailed to serve as specifications for work on individual areas. The discussion deals only with the more common of the stand conditions prevailing in forests of the four major southern types.

Improvement of forest stands is a matter of special importance in the South, because of the great value of the region's forests and its great potentialities for forest production. Among the South's many advantages as a timber-producing region are (1) its large number of valuable tree species, (2) its long growing season and abundant rainfall, (3) its relatively easy logging conditions, and (4) its proximity to great markets for forest products. The Southern States as a whole contain 191,000,000 acres of forest land, which is nearly two thirds of their total land area and is about 39 percent of the total forest area of the United States. About 92 percent of their forest area has been cut over. As a result of repeated cutting, almost annual fires, hog grazing, and past destructive turpentining practices, much of the cut-over area is not now producing good stands. A well-conceived and well-executed program of stand-betterment work would go far toward restoring the cut-over lands to full productivity.

MAJOR FOREST TYPES

To simplify the presentation of stand-improvement measures, the South is considered here as made up of four main divisions, occupied respectively by (1) the longleaf-slash pine type, (2) the longleaf pine-scrub oak type, (3) the shortleaf-loblolly pine-hardwood type, and (4) the southern bottom-land hardwood type. Each of these four major type classifications includes several of the types defined by a committee of the Society of American Foresters.[2] Throughout this publication the term " forest type " is used in a broad sense to indi-

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[1] " The South " here indicates the region shown by the shaded portion of the map on p. 2, extending from eastern Virginia to eastern Texas and including parts of Arkansas, Oklahoma, and Missouri. Conditions in the piedmont region, the southern Appalachian Mountains, and the hardwood uplands of the central Mississippi Basin are not discussed here. Stand-betterment work in southern Appalachian forests is treated in Measures for Stand Improvement in Southern Appalachian Forests, Emergency Conservation Work Forestry Publication No. 1. The information presented here has been acquired through work done by the Southern Forest Experiment Station and through the experience of timber operators in the region.

[2] Forest Cover Types of the Eastern United States. Report of the Committee on Forest Types, Society of American Foresters. Journal of Forestry, 30 : 451–498.

cate a group of related associations of forest species to which similar stand-betterment treatments can be applied.

The tree species that commonly occur in each of the four major southern forest types are listed in appendix A, page 33. Shrubs and vines common in the forests of the South are listed in appendix B, page 35.

The map appearing as figure 1 shows the distribution of the four main southern forest types. The broad divisions shown are those in which the types indicated, respectively, have possession of more than

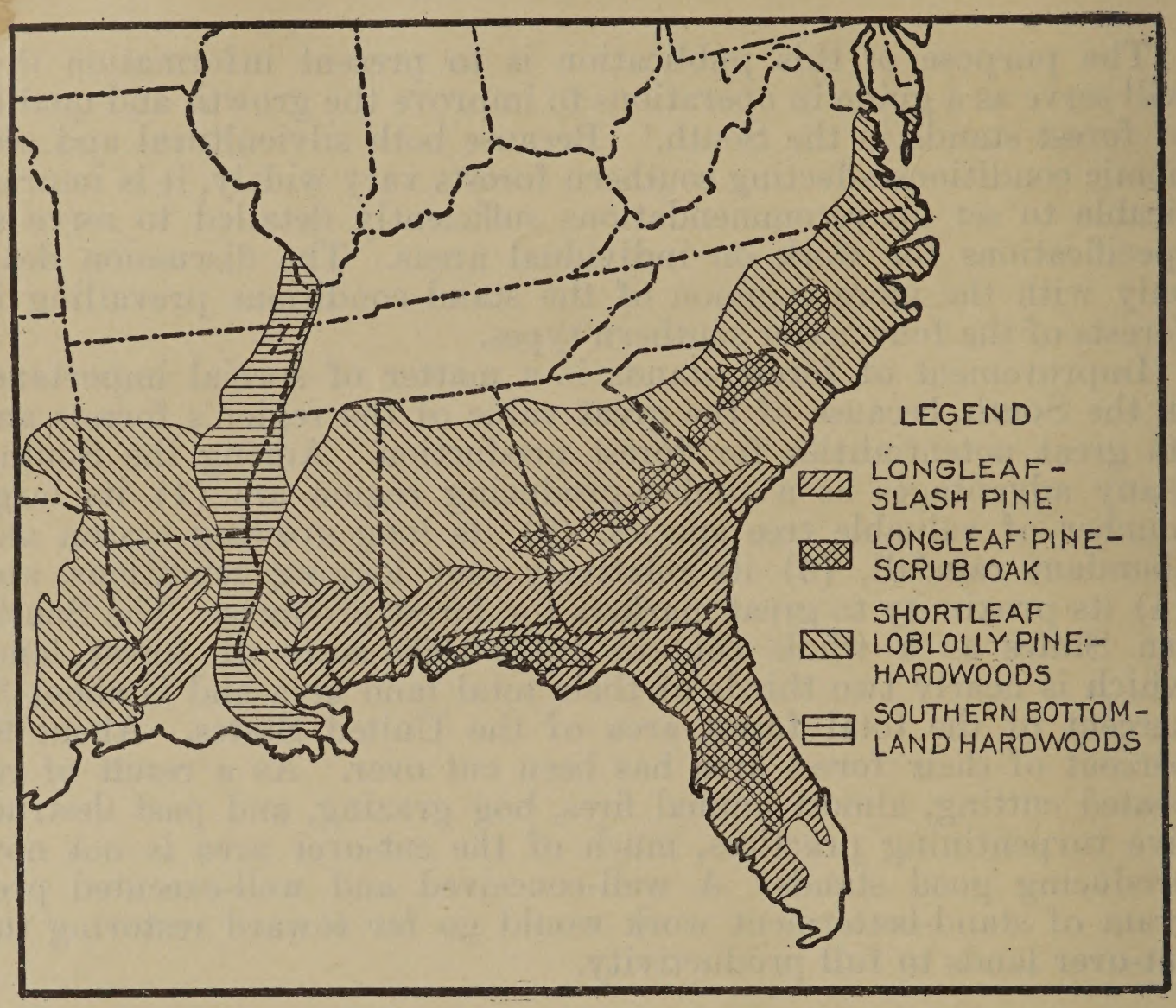

FIGURE 1.—Distribution of forest types of the South.

50 percent of the forest area. In each of these divisions, types other than the characteristic type occur here and there and in some instances dominate considerable areas.

LONGLEAF-SLASH PINE TYPE

The longleaf-slash pine forest type occupies a broad belt along the South Atlantic Coast and Gulf Coast from the vicinity of Raleigh, N.C., to the Trinity River in eastern Texas, a distance of about 1,000 miles. This type is characterized by longleaf pine (*Pinus palustris*) and slash pine (*P. caribaea*) occurring both pure and in mixture. Slash pine frequently occurs in mixture with swamp hardwoods on the edges of swamps. It does not appear north of South Carolina or west of the Mississippi River. Loblolly pine (*P. taeda*) commonly occurs in mixture both with longleaf and with slash

pine. A less common associate of these species is pond pine (*P. rigida serotina*). More rarely, shortleaf pine (*P. echinata*) and spruce pine (*P. glabra*) occur. Longleaf and slash pine are by far the most desirable species of the type.

In the whole of the longleaf-slash pine belt, the only forests of other types are the extensive hardwood forests of the Mississippi River flood plain and narrow belts of hardwood forest on alluvial lands bordering other rivers and streams; longleaf pine-scrub oak forests on dry, sandy hills; stands of black gum (*Nyssa sylvatica*), tupelo gum (*N. aquatica*), and southern cypress (*Taxodium distichum*) in bays and swamps; and stands of pond cypress (*T. ascendens*) and swamp black gum (*N. biflora*) in ponds. Cutting operations covering approximately 95 percent of the area have removed most of the old-growth timber. Much of the cut-over area has restocked with advance second-growth timber; a part is now in process of restocking with seedlings; and a part has not restocked at all.

The longleaf-slash pine type is of outstanding economic importance not only to the South but to the Nation as a whole. In addition to producing lumber, poles, piling, ties, and pulpwood, forests of this type produce nearly 70 percent of the world's supply of naval stores, including rosin, turpentine, rosin oil, pitch, and tar.

Stand-improvement work on a large scale in the longleaf-slash pine type will deal principally with two stand conditions. The most prevalent condition, and the one in which stand-improvement work is most profitable, is that represented by extensive stands of approximately even-aged second-growth longleaf pine, with or without some admixture of slash pine. These stands are the result of natural reseeding on cut-over areas. Stands of this description that are now from 20 to 25 years old and average from 3 to 5 inches in diameter at breast height occupy large aggregate areas in south Georgia, in north and west Florida, in southern Alabama, and in southeastern Mississippi. Stands of similar condition but of more advanced age are found in the Carolinas. Younger stands are common in Louisiana and eastern Texas. Throughout the type area, approximately even-aged stands of second growth are found in scattered blocks of from 1 acre to 50 acres or more. The second principal condition to be dealt with in stand-betterment work on a large scale is represented by stands including at the present time an upper story of old growth or of advance second growth 40 to 80 years old and an understory of trees 5 to 25 years old.

In both these conditions the stand may be of pure pine or of pine and hardwood mixed. The association of pines with hardwoods occurs at the edges of bays and swamps and along the northern boundary of the longleaf pine zone. Both in the pure pine and in the pine-hardwood association are to be found occasional individuals of the nonturpentine pine species, loblolly, pond, and spruce pine.

The second-growth stands of the longleaf-slash pine type in the eastern part of the territory occupied by the type are further advanced in growth and generally are better stocked than those in the western part, where the old growth was more recently logged and where the logging methods were such as to leave less growing stock.

LONGLEAF PINE-SCRUB OAK TYPE

The principal areas occupied by the longleaf pine-scrub oak type are located in west Florida, in the north-central portion of the Florida peninsula, and in a long, narrow strip in central Georgia and the Carolinas. The characteristic species of the type are longleaf pine and scrub oaks such as turkey oak (*Quercus catesbaei*), blue-jack oak (*Q. cinerea*), blackjack oak (*Q. marilandica*), post oak (*Q. stellata*), and southern red oak (*Q. rubra*). Common associates are hawthorn (*Crataegus* sp.), persimmon (*Diospyros virginiana*), and (in Florida) sand pine (*Pinus clausa*). The soil is characteristically a medium or fine sand, usually of the Norfolk series. It is light in color, excessively drained, and very unproductive.

When viewed from a distance, a stand of this type has the appearance of a solid block of scrub oak containing a few scattered pines. Upon closer examination the scrub oak cover seldom proves to be a solid block, but is almost always found to be made up of clumps of trees surrounding small openings. The height of the scrub oak varies from 2 to 20 feet, depending upon the age of the trees and the frequency of ground fires. Individual scrub oak trees seldom exceed 10 inches in diameter. The number of scrub oak stems per acre averages about 3,000, but sometimes reaches 75,000. The number of pine seedlings varies from none to more than 100 per acre. Local variations in type result from variations in soil-moisture conditions. The most common of these are the occurrence of the longleaf-slash pine type and the southern bottom-land hardwood type.

In contrast with the longleaf-slash pine type, the longleaf-scrub oak type has been particularly slow in recovering from heavy exploitation or destructive fires. Scrub oaks are numerous, and pine reproduction is usually inadequate.

SHORTLEAF-LOBLOLLY PINE-HARDWOOD TYPE

The shortleaf-loblolly pine-hardwood type occurs in a broad zone that parallels the seacoast from southern Maryland to central South Carolina and thence extends inland north of the longleaf-slash pine belt to eastern Oklahoma and Texas. The type is defined as that in which loblolly pine (*Pinus taeda*), shortleaf pine (*P. echinata*), or the two together make up at least 25 percent of the merchantable volume, or, in stands below saw-timber size, at least 15 percent of the number of dominant and codominant trees. The principal hardwood species of the type are southern red oak (*Quercus rubra*), white oak (*Q. alba*), post oak (*Q. stellata*), red gum (*Liquidambar styraciflua*), and hickories (*Hicoria* spp.). Within the broad territory where the type predominates shortleaf and loblolly pines often occur in pure stands on abandoned fields, but ordinarily occur in mixture with hardwoods. Stands of hardwoods occur locally.

Almost the entire area has been cut over, at different times and to various degrees. Repeated fires of various intensities have occurred throughout the area, complicating the variations caused by logging. In consequence many of the stands are understocked, the proportion of the more desirable species has decreased, and the percentage of poorly formed and defective trees has increased. The outstanding ability of both shortleaf and loblolly pine to reproduce has permitted

these species to remain in possession, but owing to frequent burning and early and frequent harvesting the present stands are mainly young and are more or less patchy in occurrence.

The proximity of the shortleaf-loblolly pine-hardwood forests to the wood-using centers of the Nation, the ease with which they reproduce, and their rapid rate of growth make them important for the production of lumber and pulpwood. Incidental products include ties, poles, and posts.

SOUTHERN BOTTOM-LAND HARDWOOD TYPE

The main body of the southern bottom-land hardwood forest occupies the bottom lands of the Mississippi River Valley extending from the mouth of the Ohio River to the Gulf. Bottom-land hardwood stands occur in all river bottoms from eastern Texas to Virginia. The type is distinct from hardwood types of the adjacent uplands and of the southern Appalachian Mountains.

In the southern bottom-land hardwood type hardwoods make up at least 75 percent of the merchantable volume or, in stands under saw-timber size, at least 85 percent of the dominant and codominant trees. The characteristic species of the type are red gum, oaks (*Quercus* spp.), ashes (*Fraxinus* spp.), and southern cypress. One or more of these species can usually be found on all areas occupied by the type. The characteristic species association found in the broad flood plains of the larger rivers, such as the Mississippi, Red, and Apalachicola, differs from that found in the narrow bottoms of secondary streams that have built no extensive flood plains. Local variation within these characteristic species associations is common. The trees commonly found in the southern bottom-land hardwood forests are listed in table 1, in order of relative desirability in different locations.

TABLE 1.—*Tree species* [1] *commonly found in the southern bottom-land hardwood forests (listed in order of relative desirability)*

Location	To be definitely favored if of good quality and thrift	To be tolerated if of good quality	To be discriminated against unless particularly good	To be removed always if competing with desirable trees
Delta and principal alluvial bottoms.	Ashes Southern cypress White oaks [2] Red gum Red oaks [2]	Cottonwood American elm Tupelo gum Sugarberry Hickories Silver maple Sweet pecan Willow Persimmon Mulberry Sycamore	Overcup oak Black gum Post oak (upland variety) Water oak (*Q. obtusa*) Cedar elm Honey locust Red maple Water hickory Live oak	Hawthorn. Ironwood. Hercules club. Swamp privet. Planer tree.
Bottoms of secondary streams, coves, etc.	Ashes White oaks [2] Yellow poplar Loblolly pine Walnut Red gum Red oaks [2] Evergreen magnolia. Southern cypress	Hickories Slash pine American elm Basswood Holly Bays Mulberry Black locust	Black gum Beech Upland post oak Laurel oak Red maple River birch	

[1] The technical names of the species listed are given in Appendix A, p. 33.

[2] The species of white oak and of red oak that are to be favored, and those that are not to be favored, are indicated in Appendix A, p. 33.

Small bodies of old-growth timber are still to be found in the alluvial bottoms bordering the Mississippi River in Arkansas, Mississippi, and Louisiana. Logging operations in the bottom-land hardwoods of these three States began in the late eighties but have been most extensive since 1915. In the State of Mississippi less than 200,000 acres of old-growth bottom-land timber remains. Most of this is in the Yazoo backwater area. It consists principally of overcup oak (*Quercus lyrata*), water hickory (*Hicoria aquatica*), Red River oak (*Q. nuttallii*), and red gum. In Arkansas, logging operations have removed most of the old-growth bottom-land hardwoods. On the alluvial lands bordering the Mississippi River in Louisiana, probably not more than 500,000 acres of old-growth timber remains uncut, and several extensive logging operations are now in progress. In the bottom lands of the larger rivers elsewhere in the South only a few stands of old-growth timber remain. These stands are rapidly being cut.

Although practically all the southern bottom-land hardwood lands have been cut over at least once, the bottom-land forests continue to contribute heavily to the hardwood industries. Lumber, cooperage stock, box and crate material, and railroad ties are all produced from them in large quantities.

Bottom-land hardwood stands that should be treated are for the most part either second growth occurring as an understory with a sparse overstory of older undesirable trees or relatively even-aged second growth on old fields that were abandoned following the Civil War. The stands in the former condition, which is much the more prevalent, are the result of an undesirable type of selective logging that removes only the choice trees of saw-log size and quality. The residual stands, containing many individuals of poor form and low value, are in many cases more of a liability than an asset from a timber-production standpoint. Usually a great part of such a stand must be removed if conditions favorable to producing a valuable stand of second growth are to be established.

STAND IMPROVEMENT

GENERAL PRINCIPLES

The purpose of stand-improvement work in the South is to put forest stands into more productive condition and, where this is necessary, into better condition to protect watersheds and soils. It is a principle of stand-improvement work that the expected benefits should largely justify the cost. The particular silvicultural and economic conditions that prevail on specific areas treatment of which is contemplated should be carefully studied, to see whether the treatment can be expected to give results commensurate with the expenditure of time and effort involved.

In a given stand certain species and certain individual trees are more desirable than others. Elements in desirability are marketability, form, rapidity of growth, adaptation to site, and resistance to wind, fire, fungi, and insects. Promoting the development of desirable species and individuals is a principal object of stand-betterment work. This purpose is effected principally through the removal of undesirable trees.

In stand-improvement operations crooked trees, excessively limby trees, and trees with small or malformed crowns should be removed unless needed for seed. Young trees should be removed if they have dead leaders or are so highly subject to wind throw on account of severe fire scarring that they probably will not live to reach merchantable size.

In selecting trees for the ultimate crop, health must be considered along with species and form. Crop trees should be free from diseases [3] that would result in poor quality, poor growth, or premature loss of the tree from the stand; and so far as is practicable, in stand-improvement operations trees that endanger the stand as sources of infection should be eliminated.

Crop trees should also be free from insect injury and resistant to insect attack. Trees of slow growth and poor vigor, or trees that have recently been badly damaged by fire or storm or that have recently sustained mechanical injury, are usually more susceptible than healthy, sound trees to attack by insects, particularly bark beetles. Removal of the less thrifty trees, and maintenance of a fairly rapid rate of growth, aid greatly in reducing the danger of insect attack and especially of outbreaks of destructive insects.

Where lumber production is the main object of management, trees with long, straight, clean stems having a high percentage of merchantable content are the most desired. Where production of naval stores is the prime object the most thrifty and full-crowned trees are the most desirable, even if the clear portion of their stems is short.

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[3] For descriptions of forest-tree diseases encountered in the East and South and suggestions as to treatment of infected trees, see Emergency Conservation Work Publication No. 2, Eastern Forest Tree Diseases in Relation to Stand Improvement. Other information on forest-tree diseases can be obtained from the Division of Forest Pathology, Bureau of Plant Industry, U.S. Department of Agriculture, Washington, D.C.

Exact spacing of trees in a thinned stand is usually impracticable, and is not sought as an end in itself. The governing principle is to leave as nearly as possible the desired number of trees per acre so situated that each tree has room to develop properly, and to provide that the site be utilized as fully as possible by trees of desired form, condition, and species. The average distance from a given crop tree to its three nearest neighbors should be considered the measure of spacing.

Spacing rules can be applied more rigidly in sapling stands than in stands of larger second growth, because in the sapling stands the trees usually are more uniform in size and condition.

When the crop trees have been selected the immediately adjacent competing stems are cut, except perhaps seedlings below waist height. A check of spacing should be made frequently by counting the trees left. (In practice a common fault is to leave more stems per acre than is intended.)

The justifiability of intensive stand-betterment work is affected by the availability or nonavailability of well-developed markets for forest products.

Stand-betterment work as such is seldom justified in stands that are ready or almost ready for logging or other utilization. In very young or very inferior stands it is often inadvisable to undertake stand-betterment work of an intensive type.

DEFINITIONS

Stand-improvement treatments may be classified under five general heads: Cleaning, thinning, improvement cutting, liberation cutting, and planting. Usually an improvement operation includes two or more of these treatments. The treatment classification used in this publication is as follows:

Cleaning.—Cutting made in a stand not yet past the sapling stage [4] for the purpose of removing shrubs, vines, and trees of undesirable form or species that are injuring or are likely to injure promising trees. Synonym: Weeding.

Thinning.—Cutting made in a dense immature stand for the purpose of increasing the growth rate of the trees that are left and of improving the composition and quality of the stand either from the timber-production or from the gum-production point of view.

Improvement cutting.—Cutting in a forest that has passed the sapling stage, the main object being to remove trees of undesirable form, condition, and species. It is always for the purpose of bringing the stand into better condition and composition for silvicultural management.

Liberation cutting.—Cutting in which desirable understory trees are freed from suppression by removal of undesirable overstory trees.

Planting.—Setting out young trees to supplement or to establish forest stands.

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[4] A tree is considered to have entered the sapling stage when it reaches a height of 3 feet, and to have passed beyond the sapling stage when it reaches a breast-height diameter of 4 inches.

GENERAL PRACTICES[5]

MARKING, CUTTING, GIRDLING, AND PRUNING

Until field crews become skilled, or unless supervision is very close, improvement cuttings will result more satisfactorily if the trees are marked for cutting. Either the trees to be left or the trees to be removed may be marked; in very dense stands it is cheaper and more satisfactory to mark the trees to be left. When this is done, lime wash or paint may be used instead of the ax, to avoid scarring the trees. If fewer trees are to be cut than are to be left, the trees to be removed may be blazed with an ax or hatchet. After a stand is marked and thinned some correction cutting is usually required. The necessity of this second cutting can be avoided if the marking crew works just ahead of the cutting crew and so is enabled to make corrections as the work progresses.

After cutting foremen and cutting crews become acquainted with the principles of stand improvement under the various conditions encountered, and become experienced in the work, the marking can be eliminated. It is good practice to rotate cutting crews and marking crews in the beginning, so that all workers may soon become sufficiently skilled to warrant abandonment of marking. Under this practice a few of the cutters lead off, cutting conservatively, removing only obviously defective, suppressed, and otherwise undesirable trees. They are followed closely by the foreman and one or more cutters who complete the operation by removing some of the doubtful trees.

In all stand-betterment operations in forests of the shortleaf-loblolly pine-hardwood type and of the bottom-land hardwood type, damage to young growth may result from felling the larger trees. For this reason, and also for the sake of economy, undesired hardwood trees more than 6 inches in diameter at breast height should usually be girdled rather than felled. Felling is preferable to girdling, however, for all hardwoods so weak at the butt that if girdled they would be likely to fall soon thereafter and thus damage desirable young growth. The removal of pines should always be by felling.

Circumstances sometimes justify pruning widely spaced and limby trees, particularly in very open stands of slash and longleaf pine that are to be turpentined. The cutting should be done neatly, close to the trunk, with a sharp ax or saw. In stands that are to be turpentined, pruning should not reduce crown length to less than two thirds of the tree's total height. This rule limits effective pruning to trees that are at least 20 feet tall.

ORGANIZATION OF CREWS

It has been found that seven men and a foreman make an efficient unit for both marking and cutting under the average conditions encountered in stand-betterment operations. For planting, a two-man crew is recommended.

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[5] Planting practices are discussed in a later section, p. 27.

PROVISION AGAINST INSECT DAMAGE

Under some conditions slash left on the forest floor after cuttings attracts bark beetles to the remaining stand. In the South danger of this kind is greater if the cutting takes place in the period from March to November, inclusive, than if it takes place at another time of year. As a safety measure slash may be burned in piles concurrently with the cutting. In the hardwood forest the danger of insect infestation resulting from leaving slash on the ground is slight. The possibilities of insect damage vary so widely with forest conditions that aside from the distinction as to season of cutting no general rule for preventing such damage can be laid down.

The most destructive forest insect of the South is the southern pine beetle (*Dendroctonus frontalis* Zimm.). Information as to the life history and control of this bark beetle is given in U.S. Department of Agriculture Farmers' Bulletin No. 1586, The Southern Pine Beetle, by R. A. St. George and J. A. Beal. The turpentine borer (*Buprestis apricans* Herbst.) does serious damage to turpentined longleaf and slash pine trees, and is widely prevalent in the naval-stores belt. Information regarding this insect is contained in U.S. Department of Agriculture Circular No. 226, Control of the Turpentine Borer in the Naval Stores Region, by J. A. Beal. Southern hardwoods are subject to severe injury by a number of boring insects. So far as is now known, they are not seriously injured by any of the other insects attacking them. Further information on specific forest insects can be obtained from the Division of Forest Insects, Bureau of Entomology, U.S. Department of Agriculture, Washington, D.C.

Insect outbreaks noted in the field should be reported immediately to the Division of Forest Insects.

PROVISION AGAINST FUNGUS DAMAGE

Measures to protect the stand against fungus infection include removal of trees in which the presence of fungi is indicated by punky knots, abnormal swellings, fungus fruiting bodies, or branch and stem malformations such as cankers and galls. Stand-sanitation measures are discussed in Emergency Conservation Work Forestry Publication No. 2, Eastern Forest Tree Diseases in Relation to Stand Improvement.[6]

PROVISION AGAINST FIRE

Any stand-betterment cutting other than a very light one is likely to add materially to the fire hazard in the stand treated, for a period of from 2 to 3 years. Unless fire-protection provisions are very efficient, it is suggested that the debris be piled and burned as cutting proceeds, especially on areas adjacent to roads and firebreaks. If this is not done, care should be taken to avoid bunching the felled trees around standing trees. On firebreaks, and for a distance of

[6] Measures for control of the brown-spot needle blight of longleaf pine, caused by the fungus *Septoria acicola,* are not considered in that publication. This disease is widespread on very young longleaf pine, resulting in general retardation of height growth and in the death of many seedlings. No method of control now known can be considered practicable at present in connection with stand-improvement activities. Investigative work on this disease is being conducted by the Bureau of Plant Industry at the Southern Forest Experiment Station.

at least 150 feet from both edges of firebreaks and roads, dead trees and snags more than 6 feet tall should be felled.

TOOLS

Under average conditions the most practical felling tool for thinning is a thin-bladed ax with a wide cutting edge, weighing 2½ to 3½ pounds, or a special brush-hook with a double-edged blade. For removing scrub oak brush competing with longleaf pine a brush hook, machete, or bolo is often as good as, and sometimes better than, an ax. For felling 8-inch or larger trees, a cross-cut saw is often faster than an ax.

FIGURE 2.—Single-storied, densely stocked stand.

CLASSIFICATION OF STANDS FOR TREATMENT

In studying the composition of a given forest in order to classify it for treatment it is necessary to distinguish among the separate stands that form the forest. A stand, in the sense in which the term is used here, is a portion of a forest in which density, age composition, and species composition are relatively uniform throughout. A stand may cover many acres or only a small part of one acre. Its boundaries may be distinct or, as is more usual, one stand may blend almost imperceptibly into another.

The choice of stand-betterment measures to apply to any given stand depends on (1) the forest type; (2) whether the stand is single-storied or two-storied; and (3) the density of stocking.

Figures 2 to 6 illustrate the principal stand conditions discussed in this publication.

FIGURE 3.—Single-storied, sparsely stocked stand.

FIGURE 4.—Two-storied stand with dense overstory and sparse understory.

FIGURE 5.—Two-storied stand with sparse overstory and dense understory.

FIGURE 6.—Two-storied stand with sparse overstory and sparse understory.

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A single-storied stand is one made up of trees approximately equal in height and with a fairly uniform crown level. The trees are usually, but not always, in the same age class and of various diameters. In a two-storied stand, two distinct crown levels exist.[7] Where the trees of an upper story are separated from each other by distances averaging more than twice their height, the silvicultural effect of the upper story is negligible, and so far as treatment is concerned the stand should be classified as single storied.

A story is considered to be overdensely stocked if the trees in it are so closely spaced that they cannot continue to grow without materially interfering with each other's proper development. The number of stems per acre that characterizes an overdense stand varies with site, age, species, and purpose of management. A sparse stand is one containing so few trees per acre that the stand cannot develop satisfactorily. Such a stand does not represent the full capacity of the site, its volume being less than that the production of which is possible under the soil and climatic conditions represented. Stocking is treated more specifically in the discussions of treatment for various types.

[7] The term "two-storied" is applied in this publication to stands composed of two or of more than two stories.

STAND-IMPROVEMENT RECOMMENDATIONS, BY TYPES

LONGLEAF-SLASH PINE TYPE

With very few exceptions, forest management in second-growth longleaf-slash pine forests is concerned primarily with the production of naval stores and secondarily with the production of lumber, poles, piling, ties, pulpwood, staves, and other commodities. In the turpentine belt, stand-betterment operations consist largely of thinnings designed to hasten and enlarge the yield of naval stores.

Comparatively wide spacing results in the heaviest naval-stores yields, without involving much sacrifice of wood products. It is desirable to thin stands of young growth at a comparatively early age to a density that will encourage rapid growth and will tend, at the same time, to develop trees with straight stems free of defects and with vigorous, full crowns. Spacing so wide as to produce only bushy trees having little value for wood products should of course be avoided. Not only should crooked, defective, or stunted specimens of slash and longleaf pine be removed, but the removal of nonturpentine pines and competing hardwoods should be considered.

Table 2 defines the density classification applied in this publication to longleaf-slash pine stands.

TABLE 2. *Degrees of stocking: longleaf-slash pine type*[1]

Range in average breast-height diameter	Classification of stocking,[2] by number of trees on a 1/10-acre unit[3]				
	10	20	30	40	50 or more
0 to 2 inches	Sparse	Sparse	Sparse	Sparse	Desirable to overdense.
3 to 5 inches	do	Desirable	Desirable	Overdense	Overdense.
6 to 8 inches	do	do	do	do	Do.
9 inches or more	Desirable	Overdense	Overdense	do	Do.

[1] Recommendations as to density of stocking are based on the assumption that all stands of this type will be used primarily for gum production.

[2] "Sparse" is used in a relative sense to imply understocking, i.e., anything less than desirable stocking.

[3] A circle with a radius of 37 feet or a square 66 feet on each side has an area of 1/10 acre.

DENSE SINGLE-STORIED STANDS

In improvement operations in dense single-storied stands of the longleaf-slash pine type, the trees designated to be left standing should be either slash or longleaf pines, should be straight, and should be free from forks, scars, and other evidences of injury to the stems. They should have full and thrifty crowns, stems clear of large limbs for at least one third of their height, and a good rate of growth as indicated by the height growth made in each of the last few growing seasons. These trees should be selected from the largest, tallest, and best in the stand, and should be spaced as uniformly as is practicable. Table 3 indicates the approximate spacing desirable for

stands of given average diameters. A stand of this description is shown, before and after an improvement operation, in plate 1.

TABLE 3.—*Desirable spacing for single-storied stands of the longleaf-slash pine type*

Average breast-height diameter	Distance [1] between trees	Trees per one tenth acre [2]
	Feet	*Number*
3 to 5 inches	12	30
6 to 8 inches	15	20
9 inches or more	21	10

[1] Approximate average distance between a crop tree and each of its 3 nearest neighbors.
[2] A circle with a radius of 37 feet or a square 66 feet on each side has an area of one tenth acre.

Cleaning operations in very young stands (such as longleaf pines that have begun height growth but are still less than 8 feet tall, or slash pines less than 6 years old) are usually fraught with considerable danger that the benefits will be lost, wholly or in part, through seeding of the openings from nearby trees of rapid-growing species or through excessive development of such undergrowth as gallberry, palmetto, or scrub oaks.

A stand in which the trees to be cut average 6 inches or more in diameter may often be given the desired improvement through a utilization operation in which selected trees are turpentined and then cut for pulpwood, poles, or posts. In general, the stage at which dense single-storied young stands of the longleaf-slash pine type may best be given improvement treatment is when they are between 15 and 25 years old, or when their breast-height diameters range from 3 to 5 inches.

SPARSE SINGLE-STORIED STANDS

Table 2 indicates the approximate densities below which single-storied stands of the longleaf-slash pine type may be considered to be sparsely stocked. Stand-betterment work in sparsely stocked stands of this type will be confined largely, if not entirely, to removing the nonturpentine pines and the hardwoods. Removal of defective or poorly formed longleaf and slash pines not needed for seed is sometimes worth while where the prospects of reproduction of these species are good. The procedure in selecting trees to be reserved and trees to be removed is similar to that outlined for densely stocked stands.

Under certain conditions, as where there is a good market for pulpwood, poles, or fence posts, it is sometimes better policy not to remove sound and thrifty pines of the nonturpentine species, especially loblolly. This is especially likely to be the case if the prospect of restocking with slash or longleaf pine through natural seeding is uncertain. From a silvicultural standpoint it is often better practice to leave a sparse stand of unsatisfactory composition untouched rather than open it further and thus encourage the growth of shrubs and weeds that would add to the fire hazard and increase competition.

A, Dense single-storied 19-year-old stand of longleaf pine on the Suwannee Forest, southeastern Georgia, containing 1,100 trees per acre, many of which are overtopped and suppressed.

B, Longleaf pine stand shown in A, after it was thinned to 236 dominant and codominant trees per acre with a distance of approximately 13 feet between stems.

Longleaf pine in Alabama. In left foreground, a single-storied group. In background, a two-storied stand with sparse overstory and dense understory.

EXAMPLES OF IMPROVEMENT OPERATIONS IN SINGLE-STORIED STANDS

During the last 5 years, a considerable amount of stand-betterment work has been done in single-storied, even-aged young second-growth stands of the longleaf-slash pine type. Usually the chief purpose has been to improve the condition of the stands from the naval-stores standpoint. Such improvement operations have covered thousands of acres. The following are examples:

Each winter since 1928 the management of Suwannee Forest, a privately owned forestry operation in southeast Georgia, has improved some 500 to 2,000 acres of its sapling longleaf and slash pine stands. The woods work has been done entirely by local workmen and has been supervised by a trained forester. No effort has been made to improve stands averaging less than 200 stems per acre.

On the area treated in 1931, the stands averaged 19 years in age. Before thinning, their diameter at breast height averaged 3½ inches and their stocking ranged from 200 to 2,000 stems per acre. The aim was to leave on each acre about 250 of the best individual longleaf and slash pines, distributed as evenly as practicable. Plate 1 shows a sample of one of the stands before cutting, when it contained 1,100 stems per acre averaging 3½ inches in diameter at breast height, and after cutting, when it contained 236 trees per acre with an average diameter of 4½ inches.

At first the stands were marked by a forester before cutting. When the contractors became skilled they took over this work, doing both marking and cutting at an average rate of 1.5 man-hours per acre. Few trees more than 6 inches in diameter at breast height were cut, and the felled trees were merely left on the ground. Nothing was done to the tops, except that the big, bushy crowns of the few larger trees were lopped to hasten decay and reduce the fire hazard.

On the Osceola National Forest, in northern Florida, stand-improvement work has been in progress for several years in even-aged sapling stands of longleaf and slash pine. Several thousand acres of these stands have now been treated. On the area treated in 1931, the stand before thinning ranged from 400 to 1,200 stems per acre. The trees removed averaged 2½ inches in diameter at breast height. Trees more than 6 inches in diameter at breast height were not cut. The operation was designed to reduce the stand to approximately 200 trees per acre, more or less evenly spaced. Trees were not marked, but the cutting was supervised by an experienced foreman with each five-man crew. The finished work was entirely satisfactory. The labor requirement was as follows:

Number of trees cut per acre:	*Labor required per acre for cutting, in man hours*
200	0.8
400	1.4
600	2.2
800	3.4
1,000	5.4

Marking, during the preliminary trials, required on the average 2 man-hours per acre, aside from the requirement for cutting.

The Tennessee Coal & Iron Co., which has extensive holdings of young second-growth longleaf forests in southeastern Alabama, has

been improving its stands in recent years. In the winter of 1931–32, this company thinned 725 acres of 25-year-old stands. The number of stems per acre averaged 450 before thinning and 200 after thinning. The trees removed ranged from 1 to 5 inches in diameter at breast height, averaging 3 inches. The residual stand ranged from 2 to 10 inches in diameter at breast height, with an average breast-height diameter of 6 inches and an average height of about 40 feet. The thinning required, on the average, 1.6 man-hours per acre.

TWO-STORIED STANDS WITH DENSE OVERSTORY AND SPARSE UNDERSTORY

In a two-storied stand of the longleaf-slash pine type, a sparse understory existing under a dense overstory is not likely to be silviculturally important. In occasional situations, however, such an overstory is just open enough to have allowed a younger stand of desirable species to get a foothold. Here it is sometimes advisable to effect a further opening of the overstory by removing nonturpentine pines, hardwoods, and defective longleaf and slash pines.

In stands in which the overstory trees are large enough to be logged, the desired silvicultural effect may be had by making sure that logging operations remove the undesired species and defective trees together with the trees that would ordinarily be taken. More than ordinary care in felling and logging is needed, to restrict to a minimum the damage to the understory.

If the overstory is of the 3-inch to 5-inch diameter class, it may be given the same treatment as a single-storied stand of this size, except that the operation should leave not more than 200 trees per acre, as evenly spaced as is practicable. An overstory density greater than this would undoubtedly have a stunting effect upon the understory trees. Within 10 years after thinning, the top story will again need to be opened up in order to make room for the growing understory. At that time the overstory will probably average from 6 to 8 inches in diameter at breast height, and if market conditions permit any utilization of the cut material for poles, posts, or pulpwood it may be thinned [8] to a density of about 75 trees per acre or a spacing of approximately 24 feet.

The treatment of the understory should follow closely that prescribed in the foregoing for single-storied stands of trees of similar sizes, except that it will not be possible to grow so many trees per acre in the understory as in the single-storied stand.

TWO-STORIED STANDS WITH SPARSE OVERSTORY AND DENSE UNDERSTORY

The two-storied stand having a sparse overstory and a dense understory is a condition now prevalent throughout the longleaf-slash pine belt. The trees in the upper story, 4 to 20 per acre, in most cases have been completely worked out for naval stores and have been so badly scarred by fire and riddled by insects that they are worthless except to assure further reseeding. Even if the timber is prevailingly sound, usually the merchantable stand per acre is too light for profitable logging at the present time.

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[8] Under some conditions, the trees to be removed in the thinning process may be turpentined for a period of several years before they are cut for conversion into wood products. A few years' delay in the second liberation cutting would not be serious.

This condition is illustrated in plate 2, which shows also a single-storied stand.

The understory is usually advance growth. Such stands of advance reproduction, particularly those of slash pine, usually have developed as a result of fire protection. The understory often includes undesirable species and trees of poor form and condition, and often is poorly spaced.

Little or no treatment of the overstory is justified or feasible, except possibly the removal of undesirable species, such as pond and spruce pines, that seed abundantly and might reproduce if the understory were destroyed by fire. An understory 10 feet or more in height may be assumed to be safe from total destruction by fire except in unusually severe conflagrations. In stands in which the growth of the understory is being seriously retarded by the presence of occasional large-crowned trees in the overstory, such " wolf " trees should be removed if they have been worked out for turpentine or are of undesired species.

Where the understory trees seriously crowd each other or threaten to do so, they should be thinned. Because of the presence of the overstory, unless this is extremely open, the number of trees that can advantageously be left in the understory will probably be less than the number given in table 3. Nature will have largely taken care of this by eliminating young growth from areas immediately under standing trees, so that the proper spacing for the understory groups to be thinned will not be much wider than that given in the table for single-storied stands.

Aside from the discussion of density, the directions given (p. 15) for the treatment of single-storied stands apply also to understory stands.

TWO-STORIED STANDS WITH SPARSE OVERSTORY AND SPARSE UNDERSTORY

If both stories of a longleaf-slash pine stand are sparsely stocked, betterment of the stand is principally a matter of restocking. Where the overstory trees are so few or of such character that a natural reseeding of slash or longleaf pine is improbable or will require a long period of time, planting should be considered. The justification of planting will depend largely upon economic circumstances. Fire protection is essential until the new growth is well established. Concentrated grazing of hogs is a serious obstacle to satisfactory restocking with longleaf pine. In localities where such grazing exists, it is necessary to fence forest plantations or reforesting areas against hogs.

LONGLEAF PINE-SCRUB OAK TYPE

In the longleaf pine-scrub oak type, the main stand-improvement work to be done consists in the removal of oaks that are crowding or overtopping young pines or threatening to do so. A stand in need of such treatment is shown in plate 3. Advance scouting is needed to segregate and designate areas needing treatment. Arbitrary limits are not satisfactory, but certainly no work need be done where more than 200 pine seedlings per acre are already growing free from oak competition or where fewer than 20 pine seedlings in need of release are present. Estimates of stocking may be based upon a 5 to 10 percent reconnaissance, by 160-acre units, made well ahead of the cutting crews.

The young pines most likely to benefit by the removal of nearby oaks are those that are from 2 to 8 feet high. Occasionally it is worth while to release smaller seedlings. Cutting to liberate longleaf pines in the grass stage [9] is less fully warranted not merely because such seedlings are hard to find but because they may not survive, and if they do survive are not so likely to suffer severely from competition within a few years. Young pines that force their way through the oak canopy are generally spindly and subject to excessive whipping against the oak branches. Pines subject to such whipping should be released by cutting the adjacent oaks. Where possible, such a pine should be carefully extricated from any interfering oak branches before the oaks are cut; if this is not done, the pine may be bent and may not return to an upright position. Where the main stem or a side branch of an oak tree is within 3 feet of a pine seedling, the oak should be cut. In cases in which future interference seems especially likely to develop, for example if the oak is well above the seedling and leaning toward it, the clearance should be extended to about 6 feet (air line). In oak brush, a pine seedling is sufficiently released if competing stems are cleaned from a circle 6 feet in diameter (on the ground).

Oak sprouts less than 1 inch thick can usually be broken off by bending them over and stepping on them. Larger stems should be cut low enough to give complete release. It is not always necessary to cut entirely through the stem, provided the top is bent to the ground away from the pine; moreover, the slow death resulting from partial cutting and bending to the ground may be followed by less sprouting from the root collar. Where oaks 8 inches or more in diameter are numerous they should be either girdled or cut, the foreman passing judgment in each case as to the desirability of removing them.

The release operation can be carried on throughout the year. June, July, and August are probably the best months for it, however, as less vigorous sprouting follows cutting done in summer.

Old-growth pines, even if unmerchantable, are worth preserving as possible sources of further seeding.

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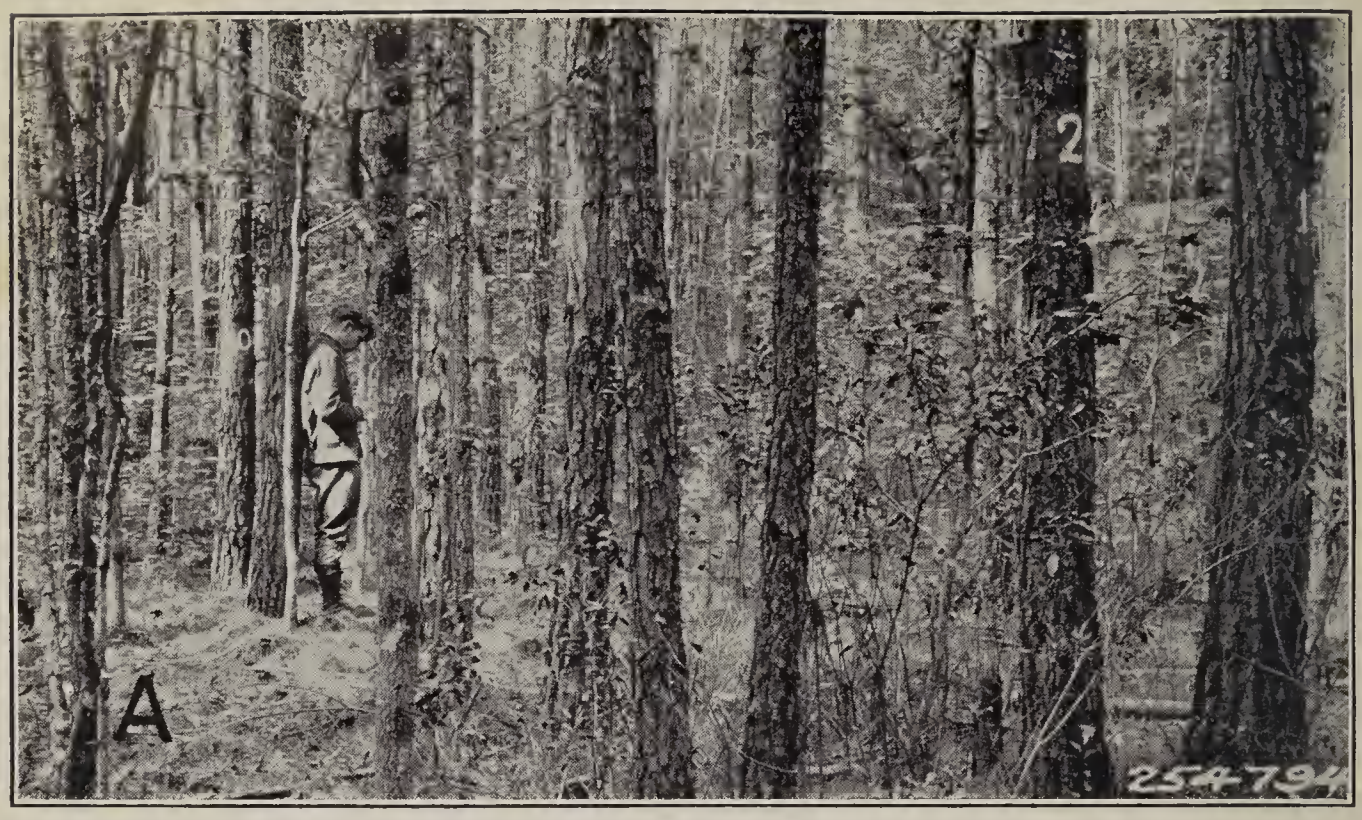
[9] The stage, of several years' duration, that precedes the beginning of height growth. In this stage the longleaf pine seedling develops a long, thick taproot, but its top remains scarcely distinguishable from surrounding grass.

Scrub oak overtopping and suppressing longleaf pine seedlings. The scrub oak should be removed.



A, Single-storied stand of loblolly pine containing 600 trees per acre. The stand is in need of thinning.

B, Stand of loblolly pine, adjacent to that shown in A, that has been thinned twice at 5-year intervals and contains 320 trees per acre. The first thinning was made 10 years prior to the date of the photograph.

SHORTLEAF-LOBLOLLY PINE-HARDWOOD TYPE

In stands of the shortleaf-loblolly pine-hardwood type, before any stand-improvement work is considered the purpose of forest management on the individual area in question should be clearly defined. Whether the main product desired is saw timber or pulpwood, the treatment should aim to place the forest in condition for optimum yield of that product.

In stands of the shortleaf-loblolly pine-hardwood type the early growth of the trees determines to a large degree their final form. Cleaning operations may best be deferred until the growth characteristics of individual trees develop, which usually occurs at an age of 8 to 10 years. Where there is danger of young pines and desirable hardwoods being eliminated by competition from trees of undesirable species, however, release should not be delayed.

Only those species that are now marketable or that are likely to become marketable should be favored. The consistently desirable species in the type are shortleaf and loblolly pine, white and red oaks except blackjack oak, and red gum. Other species are desirable in certain localities or under certain circumstances.

Individual trees are undesirable, regardless of species, if they are excessively crooked, short-boled, or limby or are infected with fungi.

Hardwoods occur in mixture in nearly all stands of shortleaf and loblolly pine. Not only do the hardwood species tend to improve site conditions through the effect of their leaf fall on the soil, but by increasing the density of the stands they shade off the lower limbs of the pines, with the result that the pine trees grow straight and clean. It is important, therefore, that hardwoods be maintained as a minor element in the stands. About 10 percent of the crop trees should be hardwoods; in addition, a sufficient number of intermediate and suppressed hardwood trees should be left to effect natural pruning of the crop trees.

Efforts to improve a stand of this type would be largely wasted unless the area were to be afforded continued protection against fire. When slash from stand-betterment operations accumulates in such quantities as to create a considerable fire risk, it should be piled and carefully burned during damp periods, or otherwise disposed of. No stand-betterment work is warranted if a dangerous accumulation of slash has to be left behind.

DENSE SINGLE-STORIED STANDS

In single-storied stands of the shortleaf-loblolly pine-hardwood type where many trees are severely crowding each other or threaten to do so, a thinning is warranted even if the stand is made up largely of undesirable species. Existing stands in this condition vary greatly as to size of trees, the average breast-height diameters of those most in need of treatment ranging from 3 to 8 inches. A single-storied stand of this type in need of thinning, and one that has been thinned, are shown in plate 4. Another such stand from which a "wolf" tree should be removed is shown in plate 5.

In sapling stands in which scattered pines are struggling with hardwoods for possession of the area, each pine to be reserved should be released by a cleaning operation removing the competing vegetation within a radius of 6 feet. The competing vegetation may be either cut or broken off.

Spacings recommended as the general standard for thinning stands of this type are shown in table 4, in terms of the approximate average distance between a crop tree and each of its three nearest neighbors. The best trees should be selected as crop trees, even if this makes the spacing a trifle short in some instances and a trifle long in others. In general, the distance between any crop tree and its nearest neighbor should be at least half the average distance specified in the table; two equally good trees may be left more closely spaced, however, if they have little other competition. All crop trees should be released from any competition that would be likely to retard their growth during the next 10 years. Trees that will not interfere with crop trees need not be cut.

TABLE 4.—*Desirable spacing for single-storied stands of the shortleaf-loblolly pine-hardwood type*

Average breast-height diameter	Distance between trees [1]	Trees per one tenth acre [2]
	Feet	*Number*
4 inches	8	68
6 inches	10	44
8 inches	12	30
10 inches	15	20

[1] Approximately average distance between a crop tree and each of its 3 nearest neighbors.
[2] A circle with a radius of 37 feet or a square 66 feet on each side has an area of one tenth acre.

While thinning is the main improvement measure for this stand condition, the treatment should include a cleaning consisting in removal of inferior species and crooked, slow-growing, or defective specimens.

SPARSE SINGLE-STORIED STANDS

In a sparse single-storied stand of the shortleaf-loblolly pine-hardwood type, stand-betterment measures should be largely confined to the removal of such undesirable species and specimens as are interfering with the development of desirable trees. Defective trees of desirable species should not be cut if they are capable of producing seed needed to restock open portions of the area. In a sparsely stocked young stand in which natural seeding of desirable species will not become possible for several years and immediate full restocking is desired, openings in the stand should be planted.

TWO-STORIED STANDS WITH DENSE OVERSTORY AND SPARSE UNDERSTORY

In two-storied stands of the shortleaf-loblolly pine-hardwood type composed of a dense overstory and a sparse understory, the overstory condition is usually similar to the condition in dense single-storied stands. If the overstory is composed of desirable trees, treatment of the understory is usually not warranted. The treatment recom-

mended for the overstory is the same as that recommended for dense single-storied stands of trees of similar size (p. 21), except that where desirable trees make up the understory all undesirable overstory trees that are suppressing understory trees should be removed to give room for the development of the latter.

TWO-STORIED STANDS WITH SPARSE OVERSTORY AND DENSE UNDERSTORY

Where a sparse overstory occurs with a dense understory in the shortleaf-loblolly pine-hardwood forest, treatment will consist in removing undesirable overstory trees in order to reduce the effects of overtopping. If there is a deficiency of the more valuable species in the understory, care should be taken to maintain a good representation of the better species in the overstory in order to seed openings in the understory that may result from subsequent accidental fires. The treatment recommended for the understory is mainly as suggested (p. 21) for a dense single-storied stand; because of the presence of the overstory, a somewhat wider spacing is recommended.

TWO-STORIED STANDS WITH SPARSE OVERSTORY AND SPARSE UNDERSTORY

Stands in which both overstory and understory are sparsely stocked are very common in the shortleaf-loblolly pine-hardwood type, largely as a result of heavy cuttings and of repeated fires. In many such stands improvement work is not justified; where it is done, it should be limited to the removal of worthless species that are retarding the development or hindering the establishment of desirable species.

Since the outstanding need in this condition is restocking with desirable species, every tree of the more valuable species that is capable of bearing seed should be left standing even if it may never have any other value. Protection from fire is a very large factor in bringing about the desired restocking. Planting is necessary only if adequate seed trees of desirable species are not available or if a cover is needed immediately for watershed protection or erosion control.

SOUTHERN BOTTOM-LAND HARDWOOD TYPE

On thousands of acres of good growing sites in the bottom lands, improvement cuttings and thinnings in old-field stands and liberation cuttings and thinnings in other second-growth stands will result in increased growth of desirable species. After such treatment the stands will contain only well-formed, desirable trees so spaced that no further treatment will be needed for at least 10 years. Table 5 shows the average spacing and average number of trees per acre in properly thinned stands of given average diameters. The recommendations in the table apply to stands under management for lumber production. Lighter thinning, which can be repeated, is desirable where a continuous market is available for pulpwood, small-dimension material, or cooperage bolts.

TABLE 5.—*Desirable spacing for southern bottom-land hardwood stands*

Average breast-height diameter	Distance between trees [1]	Trees per one tenth acre [2]
	Feet	*Number*
4 inches	10	43
6 inches	12	30
8 inches	15	20
10 inches	17	15
12 inches	19	12

[1] Approximate average distance between a crop tree and each of its 3 nearest neighbors.
[2] A circle with a radius of 37 feet or a square 66 feet on each side has an area of one tenth acre.

In the bottom lands considerable damage is often done to hardwood stands by vines, which bind the stems of trees and smother their crowns. Often vines also carry fire well up the trunks, greatly increasing fire injury. All vines that are climbing trees should be cut. In cutting a vine that adheres closely to the trunk, it is best to remove a section 2 to 3 feet in length.[10]

DENSE SINGLE-STORIED STANDS

Dense single-storied stands of the bottom-land hardwood type are usually a mixture of numerous hardwood species varying in desirability. Some pure stands of species such as red gum or southern cottonwood (*Populus deltoides virginiana*) occur on abandoned farm land or on river margins, but in general the stands contain from 3 to 15 species. Trees of desirable form and species are interspersed with trees of poor form and of less desirable species. The total number of trees (1 inch or more in diameter) per acre is approximately 1,000 to 2,000 for the 2-inch class and ranges to about 250 in

[10] Stand-improvement work in the southern bottom-land hardwood type very frequently involves exposure to poison ivy. Methods of preventing and treating ivy poisoning are described in U.S. Department of Agriculture Farmers' Bulletin No. 1166, Poison Ivy and Poison Sumac and Their Eradication (rev. 1929), by C. V. Grant and A. A. Hansen.

White oak "wolf tree" with crown spread of 60 feet occupying valuable growing space in a dense single-storied stand of loblolly pine. Such trees should be removed.

Southern bottom-land hardwood stand in Louisiana, as it appeared 4 years after a thinning that removed 11 cords per acre and left 318 trees per acre. Water oak composes more than 40 percent of the residual stand.

stands of 10-inch trees. The stocking usually is so dense as to prevent optimum development of the trees. Such a stand is shown in plate 7, A.

The object of treatment is to reduce the density of stocking so that the trees left in the stand will have opportunity for optimum development in diameter and height without opportunity for developing large spreading crowns. The desirable spacing varies with the growing capacity of the site and with the size of the individuals to be released as crop trees. In table 5 is shown a general approximation of the spacing desirable for stands of given average diameters. Trees of less valuable species are not to be cut unless they are defective or are interfering with the development of trees of more valuable species that have been selected for the final stand. In other words, a low average present rating in desirability of the species in the stand should not suggest a marked reduction in growing stock for the sake of forcing a radical change in stand composition. In the thinning process, however, all possible advantage should be taken of the opportunity to eliminate undesirable species from the stand and to remove deformed and defective individuals of desirable species. Table 1 (p. 5) lists the species commonly present in southern bottom-land hardwood forests according to site and in order of relative desirability under present conditions as to logging and utilization practices and market values. Plate 6 shows a stand of this type that has been thinned.

Recently established stands that have not yet reached a general average of 3 or 4 inches in diameter at breast height usually do not require treatment.

SPARSE SINGLE-STORIED STANDS

Sparse single-storied stands are frequent in the poorly drained bottoms. Understocking occurs also on the better bottom-land sites, as a result of severe cutting followed by frequent fires and, in some parts of the region, as a result of intensive grazing. Continued overcutting causes many areas to remain in this unsatisfactory condition. It is very questionable that planting can be recommended to remedy the understocking. On the poorer sites it is not warranted, and on the better sites natural restocking can usually be brought about by protection from fire and grazing.

TWO-STORIED STANDS WITH DENSE OVERSTORY AND SPARSE UNDERSTORY

In bottom-land hardwood stands composed of a dense overstory and a sparse understory, the understory is usually of little value and the treatment recommended for the overstory is very similar to the general procedure set up for single-storied stands of the same average diameter. Occasionally, however, the understory is of sufficient value to justify a liberation cutting. In such a case a thinning in an overstory of sapling size may be made a little heavier than usual. This will result in having a thrifty stand of advance growth at the time when the overstory is harvested. In a stand containing an overstory of saw-timber size, if the understory is of sufficient value to warrant liberation a selective cutting of the larger trees may be made somewhat heavier than it would otherwise have been. The

cutting or girdling of defective trees and trees of undesirable species in connection with logging is justified in some cases by the impetus it gives to the growth of oncoming trees.

TWO-STORIED STANDS WITH SPARSE OVERSTORY AND DENSE UNDERSTORY

The two-storied stand composed of a sparse overstory and a dense understory is a condition common over a considerable portion of the bottom-land hardwood region. Where logging has been carried on, it is typical. Such a stand is shown in plate 7, B. Trees of poor quality and of undesirable species left by logging operations often develop large spreading crowns and greatly hinder the development of young growth. Such trees are usually worthless except for fuel wood, and utilize growing space out of all proportion to their value. Unless such "wolf" trees are removed, the stand will not measure up to the capacity of the site in either quality or quantity of timber. If the understory is composed of trees of valuable species and if the overtopping residual trees are materially reducing its growth and yield, these residual trees should be killed by girdling.

In stands in this condition the size, age, composition, and density of the understory vary according to the influence of many factors in stand development. The stand may be made up of a mixture of desirable and undesirable species and of sound and defective specimens. An object of the stand-betterment treatment recommended will be to reduce the density so that the remaining trees can grow for at least 10 years without crowding. Another object will be to improve the composition of the understory through releasing desirable individuals and removing undesirable species and defective individuals of all species. These measures are similar to those recommended (p. 24) for single-storied stands of similar size and composition. As in those stands, it is recommended that thinning be postponed until the understory trees are 3 to 4 inches in diameter.

TWO-STORIED STANDS WITH SPARSE OVERSTORY AND SPARSE UNDERSTORY

Two-storied stands composed of a sparse overstory and a sparse understory are frequent on the poorer bottom-land hardwood sites where logging has taken place. On many such sites reproduction has been retarded by fires and grazing. As in the conditions previously described, the overstory is composed principally of old residual defective and undesirable trees. The sparse reproduction is in many cases badly scarred by fire. Poor drainage or poor soil conditions prevent the establishment or growth of a valuable stand of timber. Little in the way of stand-betterment work can be recommended for this condition. Protection from fire and overgrazing may sometimes effect a slow and gradual restocking in the understory. Planting to fill in open spaces is not recommended.

FOREST PLANTING

In many instances planting is the only effective method of improving a forest stand, either because the land fails to restock naturally or because it restocks with species of little or no value, such as scrub oaks. Both situations are common throughout the South. Planting on lands where active gullying or sheet erosion is in progress is discussed in the section on erosion control (p. 30).

Setting out young trees is almost always more effective than direct seeding. The effectiveness of planting depends, however, on using stock hardy enough to stand the shock of transplanting and capable of withstanding site conditions.

Important decisions preparatory to the planting operation have to do with the choice of species and the choice of spacing.

As a general rule it is best to use species that previously grew on the land to be planted or that are growing well on similar soil nearby. It is sometimes desirable to plant a mixture of two species that appear to be equally well suited to the site and equally capable of making rapid growth. The soil preferences of different species and their ability to tolerate adverse factors must be taken into account. In the longleaf pine region, for example, longleaf pine does better than other species on very deep, dry, coarse sands and on the more moist sites having a heavy clay subsoil 6 to 10 inches beneath the surface; except on the deep dry sands, however, planted longleaf pine is less able than other pines to survive and make good growth in competition with a dense cover of scrub oaks or other brush. In the southern and eastern part of the longleaf pine region, slash pine grows well on all except the deep, dry, sandy soils; if planted farther north, however, it is subject to wind throw when winter storms load its foliage with sleet. Within its range, slash pine tends to do better on wet sites than any of the three other principal species of southern pine. Loblolly pine through most of its range requires a better-drained site than other species, a more constant supply of moisture, and a more permeable subsoil. On the drier, more adverse sites in the lower piedmont region and in the extreme northern part of the range of southern pine, shortleaf does better than loblolly.

The purpose for which the stand is to be established sometimes affects the choice of species. For naval-stores production, longleaf or slash pine is necessary. For pulpwood alone, shortleaf and loblolly pines are preferable. For planting to stabilize eroded slopes, black locust and shortleaf pine are best.

The choice of spacing is important because it affects the quantity of planting stock required, the age at which thinnings will be needed, and the quality of lumber or other products. The naval-stores pines, longleaf and slash, shed their lower branches readily, and therefore can be grown successfully with wider spacing than loblolly and shortleaf pines, which have more persistent branches. Loblolly and short-

leaf pines are injured and deformed by the attack of the pine tip moth (*Rhyacionia frustrana* Comst.), the larvae of which burrow into and kill new growth. Closer spacing is recommended for these two species than for longleaf and slash pine to force straighter growth after tip-moth injury, as well as to assist in shading off the lower branches. Longleaf and slash pines should be spaced 6 by 6, 6 by 8, 8 by 8, 10 by 10, or even 12 by 12 feet; loblolly and shortleaf pines may more advantageously be spaced 5 by 5, 6 by 6, or at most 6 by 8 feet. The numbers of trees per acre required for different spacings are as follows:

Space between trees, in feet:	*Number of seedlings per acre*
5 by 5	1,742
6 by 6	1,210
6 by 8	908
8 by 8	681
10 by 10	436
12 by 12	302

Although small lots of stock suitable for planting can sometimes be obtained by digging up 2- or 3-year-old wild seedlings in the woods or in old fields, it is generally preferable to use 1-year-old seedlings grown in forest nurseries.[11] Nursery-grown seedlings not only survive better but are almost invariably cheaper if obtained in any great quantity.

When planting stock is received in the field, unless it is planted immediately it should be "heeled in"; that is, removed from its packing and placed, in long rows about 2 inches thick, in trenches in moist ground away from direct sunlight or excessive winds. The tops of the trees should project above the trench somewhat less than they did above the surface of the nursery bed, and the roots should be well covered with moist earth firmly packed in place. If the seedlings have been tied in bundles of 50 or 100 before packing, it is better to loosen the bundles before "heeling in", to make sure that all the roots are brought into contact with moist soil. Brush, or old sacks on light frames, can be used to keep the sun off the "heeled-in" trees. The roots of planting stock must never be allowed to dry out, even for an instant.

The forest planting tool most commonly used in the South is the planting bar. This tool is about 45 inches long over all, weighs about 10 pounds, and has a D-handle at the upper end; at the lower end it terminates in a wedge-shaped, knife-edged steel blade 10 inches long, 3 inches wide, and ¾-inch thick at the top where it is welded to the handle. One style has a 3-inch step bolted or welded to the top of the blade at one side. The planting bar works well on all soils, except those that are very hard or very stony.

The most generally successful method of using the planting bar is the following two-man method: One man makes a slit in the ground by pressing or jabbing the blade of the bar straight downward, working the tool back and forth just enough to loosen it, and then withdrawing the blade. The second man inserts the roots of a seedling in the slit, shakes them into as natural a position as possible, and

[11] U.S. Department of Agriculture Leaflet No. 35 tells how to grow southern pine seedlings in small nurseries. Several of the Southern States have issued bulletins on nursery practice for pines or for both pines and hardwoods.

A, Dense young stand of southern hardwoods in need of treatment that would reduce the number of stems to about 300 per acre.

B, Two-storied densely stocked hardwood forest in bottom lands of the Mississippi River. The scattered larger trees composing the overstory are willow oak, swamp red oak, and American elm. The understory contains ash, sugarberry, hawthorn, and cedar elm. No treatment is recommended for this stand until the overstory has been logged.

A, Gully near Holly Springs, Miss., treated in preparation for erosion-control planting. Check dams have been built, and the gully rims have been plowed so that the loosened soil will spread over the slopes and be caught behind the dams, providing opportunity for planting locust or pine.

B, Gullied field in Carroll County, Miss., 2 years after erosion-control work was begun. In August 1930 brush check dams were built and the gully rims were plowed in. Black locusts planted in the spring of 1931 had reached heights of from 6 to 9 feet by June 1932. In combination with Bermuda grass, the locusts have partially checked abnormal erosion.

then holds the seedling in position as nearly as possible at the same depth at which it grew in the nursery. The first man then drives the blade of the planting bar forward into the ground at an angle, 3 or 4 inches behind the seedling, and closes the bottom of the slit containing the seedling by bearing downward on the handle of the bar. After withdrawing the bar from the second slit, he closes the top of the first slit with his heel. Two men working together in this way can usually plant 2,000 seedlings in 8 or 10 hours.

On the less favorable soils it is necessary to use a grub hoe or mattock, dig a hole large enough to take the root system of the seedling in a natural position, and fill in soil around the roots by hand, packing the soil firmly when the hole is half full and again when it is full. The mattock may be used either by a two-man crew or by a man working alone.

The roots of seedlings should be kept moist throughout the planting operation. The best way to do this is to carry the seedlings in a pail, shallow tray, or common market basket with one layer of moist sphagnum moss in the bottom and another over the roots.

In planting pine seedlings it is not necessary to prepare the site in advance by furrowing or by clearing spots. The rows can be kept straight by having the end man in the line of planters sight on two flags placed one behind the other some distance ahead of him. Many planters prefer to prepare the site by plowing shallow furrows. Such furrows should not be more than 3 or 4 inches deep. The furrow method results in straighter rows and makes planting slightly easier, but does not necessarily increase survival. Longleaf pine seedlings planted in furrows sometimes do very poorly because soil from the sides of the furrow washes in on the almost stemless buds and either kills the trees or stunts their growth. Plowing is impracticable on areas having a heavy brushlike cover of gallberry and palmetto.

The time for planting is during the dormant season, preferably when the ground is not frozen and when the weather is favorable for careful work. In the Gulf Coastal Plain, and elsewhere in Georgia and Florida, the planting season is practically limited to December and January. In North Carolina the ideal season for planting southern pines is February and March. Because of the danger of frost heaving, fall planting is undesirable in regions where the ground freezes often or for long periods.

Absolute fire protection is essential to the survival of young plantations. Longleaf pine plantations must be protected also from hogs, which root out the seedlings to eat the bark of the roots. A range hog is capable of destroying an acre of longleaf pine plantation in a day.

EROSION CONTROL

In the Gulf States, abnormal soil erosion resulting from unwise agricultural practices has caused the abandonment of millions of acres of once productive cultivated land. On many of the abandoned areas, gullying has reached such an advanced stage that the cost of restoring soil conditions suitable for agriculture is prohibitive. Trees or other vegetation can, however, be grown on these gullied lands, and in addition to controlling erosion may yield returns in wood products or forage.

Because the soils exposed in gullies are in most instances unproductive, certain measures must be taken to improve soil conditions before a vegetative cover is established on gullied lands. The operation involves (1) correcting the drainage conditions that have caused the erosion damage; (2) constructing small brush or check dams within the gullies; and (3) breaking down the edges of gully banks and planting soil-binding vegetation. Details of these measures are as follows:

(1) Each area should be carefully examined and considered as a drainage unit. On any cultivated land in the basin above the gullies, terraces should be constructed, contour plowing should be practiced, and winter cover crops should be grown. Steep, easily erodible slopes on which erosion cannot be adequately controlled by the treatments just described should be converted to sodded pasture or woodland as soon as possible.

(2) Small check dams should be used within the active gullies. Directions for locating, constructing, and maintaining such dams are given in U.S. Department of Agriculture Farmers' Bulletin No. 1234.[12]

(3) Gully rims, and pinnacles that are being eroded, should be broken down in order to provide soil deposits on which a vegetative cover can be established. Topsoil loosened in this way is spread over the gully slopes by subsequent rains, and some of it is caught behind the check dams. The pinnacles can be broken off with a mattock or a spade. Within 5 to 10 feet of the outside of the gully rim the soil should be plowed. Gully rims so steep and irregular that it is impracticable to plow them should be broken down and loosened by hand. If areas on which erosion is in progress are to be planted in the spring, plowing or spading should be done not later than the preceding fall or early winter. Where gully banks are very steep, tree planting may well be deferred for a full year after plowing in order to permit further stabilization of the soil. Uneroded areas adjoining gullies should be plowed prior to planting. In order to hold the soil of gully banks in place, and to prevent

[12] Ramser, C. E. Gullies: How to Control and Reclaim Them. 44 p. illus. 1922. See also the same author's Brief Instructions on Methods of Gully Control, issued in mimeographed form by the U.S. Department of Agriculture, Bureau of Agricultural Engineering, August 1933.

further washing, grass, legumes, trailing vines, or trees should be planted.[13]

Areas on which erosion-control efforts are in progress are shown in plate 8.

Among valuable soil-binding plants, Bermuda grass (*Capriola dactylon*) and common lespedeza (*Lespedeza striata*) are outstanding. In general, lespedeza should be planted in the gully bottoms, behind dams, and on the more gentle slopes. Bermuda grass is especially good for holding the soil on the steeper slopes. If either of these grasses is to be propagated by sowing, the seed should be sown in April or May, Bermuda grass seed at the rate of 5 pounds per acre and lespedeza seed at the rate of 25 pounds per acre. So far as possible, all seeded slopes should be covered with a very thin mulch of straw. Bermuda grass is usually propagated by setting out sod or pieces of the rootstocks and stolons during the growing season.

Kudzu-bean (*Pueraria thunbergiana*) and trailing honeysuckle (*Lonicera japonica*) are excellent soil-binding vines. Since they damage trees, however, they are not recommended for use on gullies where trees are planted, except for occasional use of the latter to reinforce check dams.

Tree species recommended for binding the soil of gully banks are black locust (*Robinia pseudoacacia*), shortleaf pine, and loblolly pine, all of which are valuable also for their wood products. Black locust does best on clays and clay loams, and should seldom, if ever, be planted on loose sands. Shortleaf and loblolly pines grow especially well on the more friable sandy soils. Loblolly pine should not be planted on very dry sites, but it does well on the more moist sandy loams and sandy clay soils. On very dry and inferior sands, shortleaf pine is more effective in erosion control than is either black locust or loblolly pine.

For planting on the moist and usually fertile soil deposits above check dams, such species as black locust, red gum, yellow poplar (*Liriodendron tulipifera*), ash, oak, Osage-orange (*Toxylon pomiferum*), hardy catalpa (*Catalpa speciosa*), cottonwood (*Populus* spp.), and willow (*Salix* spp.) are suggested. Cuttings of cottonwood and willow are especially useful when planted in connection with brush check dams, since they provide anchorage and aid in catching soil.[14]

One-year-old hardwood nursery stock is suitable for planting to control erosion. Stock ranging from 2 to 3 feet in height should be chosen if possible. Seedlings grown naturally in the woods may be used, if they are locally available in sufficient quantities, have well-developed root systems, and are free from injury by fire, insects, or rot.

Among different kinds of nursery-grown loblolly and shortleaf pine stock, trees that have had 1 year in the nursery bed and 1 year in the transplant bed show the highest survival rate in erosion-control plantings. Shortleaf plants 10 inches or more in height and

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[13] See U.S. Department of Agriculture Farmers' Bulletin No. 1697, Using Soil-binding Plants to Reclaim Gullies in the South, by H. G. Meginnis.

[14] In the absence of supplies of black locust seedlings, it is possible that root cuttings of black locust and stem cuttings of Osage-orange may satisfactorily be used. The suitability of such cuttings for erosion-control planting has not been definitely determined.

loblolly at least 15 inches in height are more satisfactory than smaller sizes. Although 1-year nursery-grown pine stock can be used for the control of gullying, only the larger and most vigorous plants are suitable for this use.

In general, for plantations on uneroded areas adjacent to gullies a 6- by 6-foot spacing is recommended. On slopes where erosion is actively in progress a 4- by 4-foot spacing is advisable, to offset the expected heavier mortality and to provide promptly the cover necessary to prevent further washing. For planting within gullies, regularity of spacing is of no great importance; the trees should be planted on the most favorable spots, even if the resulting arrangement is quite irregular. A tree should not be planted where it will be subjected to especially severe erosion if an adjacent more stable site is available.

Maintenance measures necessary for adequately safeguarding the investment in erosion control are (1) dam inspections after each heavy rain, and dam repairs, and (2) complete protection of planted areas from fire and from livestock until the planted stock is beyond danger of injury. On the more level planted areas, the soil around the trees should be cultivated once or twice during the first growing season.

SITE-IMPROVEMENT MEASURES

In the coastal plain region, drainage of low-lying areas greatly improves conditions for forest growth. In portions of the region known as the flatwoods, shallow ponds and swamps containing stunted tree growth make up as much as 30 percent of the forest area. Both longleaf and slash pine grow much more rapidly on the better-drained sites than in the shallow ponds and intermittently wet areas.

Many of the ponds now supporting slash pine and pond cypress could be drained by ditching. A natural outlet for the water would be located and the excess water would be carried to this outlet by means of drainage ditches from one pond to another, each pond being drained into an adjoining one till the final outlet was reached. The last ditches in the chain would have to be somewhat deeper than the first.

It is not recommended that deep drainage channels be dug. The ditches seldom need be more than 1½ to 3 feet deep. Often a double-plowed furrow with some additional shovel work will answer the purpose.

The location of the drainage ditches should be determined on the basis of a field survey preceding any actual improvement work. For any area on which drainage operations are undertaken, a contour map should be prepared in advance. This map will make it possible to locate the ditches in such a way as to obtain maximum results.

The improvement plan should give definitely the location, size, and gradient of all proposed ditches and furrows. It should be kept in mind that the ditches can be made to serve also as firebreaks.

APPENDIX A

TREES COMMONLY OCCURRING IN THE FOUR MAJOR SOUTHERN FOREST TYPES

The following list includes the tree species that commonly occur in the four major forest types of the South. It does not include all the tree species found in these types. Boldface type indicates species of commercial importance within the type, and asterisks indicate species that seldom develop to saw-log size. Other trees listed sometimes reach saw-log size, but are seldom of commercial importance.

Longleaf-slash pine

Common name	Scientific name
Cypress, pond	Taxodium ascendens.
Dogwood, flowering *	Cornus florida.
Gum, swamp black	Nyssa biflora.
Maple, red *	Acer rubrum.
Oak, blackjack *	Quercus marilandica.
Oak, bluejack *	Quercus cinerea.
Oak, live *	Quercus virginiana.
Oak, post	Quercus stellata.
Oak, southern red	Quercus rubra.
Pine, loblolly	Pinus taeda.
Pine, longleaf	Pinus palustris.
Pine, pond	Pinus rigida serotina.
Pine, sand	Pinus clausa.
Pine, slash	Pinus caribaea.

Longleaf pine-scrub oak[1]

Dogwood, flowering *	Cornus florida.
Gum, black *	Nyssa sylvatica.
Hawthorn *	Crataegus spp.
Hickory, mockernut *	Hicoria alba.
Hickory, pignut *	Hicoria glabra.
Oak, blackjack *	Quercus marilandica.
Oak, bluejack *	Quercus cinerea.
Oak, live *	Quercus virginiana geminata.
Oak, post *	Quercus stellata.
Oak, southern red	Quercus rubra.
Oak, turkey *	Quercus catesbaei.
Persimmon *	Diospyros virginiana.
Pine, longleaf	Pinus palustris.
Pine, sand	Pinus clausa.

Shortleaf-loblolly pine-hardwood

Ash, white	Fraxinus americana.
Beech	Fagus grandifolia.
Beech, blue*	Carpinus caroliniana.
Cedar, eastern red	Juniperus virginiana.
Dogwood *	Cornus florida.
Elm, American	Ulmus americana.
Elm, winged	Ulmus alata.
Gum, black	Nyssa sylvatica.

[1] The oak species listed here occur in this type principally in scrub form.

Common name	Scientific name
Gum, red	Liquidambar styraciflua.
Hawthorn* (many species)	Crataegus spp.
Hickory	Hicoria buckleyi arkansana.
Hickory, bitternut	Hicoria cordiformis.
Hickory, mockernut	Hicoria alba.
Hickory, pignut	Hicoria glabra.
Holly *	Ilex opaca.
Hop-hornbeam*	Ostrya virginiana.
Magnolia, evergreen	Magnolia grandiflora.
Maple, red	Acer rubrum (and varieties).
Oak, black	Quercus velutina.
Oak, blackjack*	Quercus marilandica.
Oak, pin	Quercus palustris.
Oak, post	Quercus stellata.
Oak, Shumard red	Quercus shumardii.
Oak, southern red	Quercus rubra.
Oak, water	Quercus nigra.
Oak, white	Quercus alba.
Oak, willow	Quercus phellos.
Pine, loblolly	Pinus taeda.
Pine, shortleaf	Pinus echinata.
Poplar, yellow	Liriodendron tulipifera.
Sassafras*	Sassafras variifolium.

Southern bottom-land hardwood

Ash, green	Fraxinus pennsylvanica lanceolata.
Ash, water	Fraxinus caroliniana.
Ash, white	Fraxinus americana.
Bay, red*	Persea borbonia.
Bay, swamp*	Persea pubescens.
Bay, sweet	Magnolia virginiana australis.
Beech	Fagus grandifolia.
Beech, blue*	Carpinus caroliniana.
Birch, river	Betula nigra.
Box elder	Acer negundo.
Cedar, southern white	Chamaecyparis thyoides.
Cottonwood, southern	Populus deltoides virginiana.
Cypress, pond	Taxodium ascendens.
Cypress, southern	Taxodium distichum.
Dogwood *	Cornus florida.
Elm, American	Ulmus americana.
Elm, cedar	Ulmus crassifolia.
Elm, winged	Ulmus alata.
Gum, black	Nyssa sylvatica.
Gum, red	Liquidambar styraciflua.
Gum, swamp black	Nyssa biflora.
Gum, tupelo	Nyssa aquatica.
Hawthorn* (many species)	Crataegus spp.
Hickory, bigleaf shagbark	Hicoria laciniosa.
Hickory, bitternut	Hicoria cordiformis.
Hickory, mockernut	Hicoria alba.
Hickory, nutmeg	Hicoria myristicaeformis.
Hickory, pignut	Hicoria glabra.
Hickory, pignut	Hicoria leiodermis.
Hickory, shagbark	Hicoria ovata.
Hickory, water	Hicoria aquatica.
Holly *	Ilex opaca.
Hop-hornbeam*	Ostrya virginiana.
Locust, honey	Gleditsia triacanthos.
Locust, water *	Gleditsia aquatica.
Magnolia, evergreen	Magnolia grandiflora.
Maple, red	Acer rubrum (and varieties).
Maple, silver	Acer saccharinum.

Common name	Scientific name
Oak, bur [2]	Quercus macrocarpa.
Oak, laurel [5]	Quercus laurifolia.
Oak, live [4]	Quercus virginiana.
Oak, overcup [4]	Quercus lyrata.
Oak, pin [3]	Quercus palustris.
Oak, post [4]	Quercus stellata.
Oak, Red River [3]	Quercus nuttallii.
Oak, shingle [5]	Quercus imbricaria.
Oak, Shumard red [3]	Quercus shumardii.
Oak, southern red [5]	Quercus rubra.
Oak, swamp chestnut [2]	Quercus prinus.
Oak, swamp post [2]	Quercus mississippiensis.
Oak, swamp red (cherrybark) [3]	Quercus rubra leucophylla and Quercus rubra pagodaefolia.
Oak, water [3]	Quercus nigra.
Oak, water * [5]	Quercus obtusa.
Oak, white [2]	Quercus alba.
Oak, willow [3]	Quercus phellos.
Pecan	Hicoria pecan.
Persimmon	Diospyros virginiana.
Pine, loblolly *	Pinus taeda.
Pine, spruce	Pinus glabra.
Poplar, yellow	Liriodendron tulipifera.
Sassafras *	Sassafras variifolium.
Sugarberry (hackberry)	Celtis laevigata.
Sycamore	Platanus occidentalis.
Titi *	Cliftonia monophylla.
Willow, black	Salix nigra.

APPENDIX B

SHRUBS AND VINES COMMON IN FORESTS OF THE SOUTH

In this list, asterisks indicate species that commonly interfere with the reproduction of desirable tree species. So far as possible, the nomenclature followed is that of Standardized Plant Names, published in 1924 by the American Joint Committee on Horticultural Nomenclature. Other references used include the Check List of the Forest Trees of the United States, by George B. Sudworth (U.S. Department of Agriculture Miscellaneous Circular 92), and Flora of the Southeastern United States, by J. K. Small, published in 1913.

Common name	Scientific name
Alder	Alnus rugosa.
Arrow-wood	Viburnum nitidum.
Bamboo-brier	Smilax auriculata.
Bamboo-brier	Smilax bona-nox.
Blackberry*	Rubus spp.
Blueberry	Polycodium neglectum.
Blueberry	Polycodium stamineum.
Buttonbush	Cephalanthus occidentalis.
Ceratiola	Ceratiola ericoides.
Cross-vine	Bignonia capreolata.
Dahoon	Ilex cassine.
Deer-plum*	Chrysobalanus oblongifolius.
Dogwood	Cornus stricta.
Dogwood, flowering	Cornus florida.
Elderberry	Sambucus canadensis.
Fringetree	Chionanthus virginica.
Gallberry*	Ilex glabra.

[2] White oaks to be favored.
[3] Red oaks to be favored.
[4] White oaks not to be favored.
[5] Red oaks not to be favored.

Common name	Scientific name
Grape, muscadine	Vitis rotundifolia.
Grape, sweet winter	Vitis cinerea.
Greenbrier	Smilax glauca.
Haw, possum	Viburnum nudum.
Haw, red	Crataegus spp.
Huckleberry	Vaccinium nitidum.
Huckleberry, dwarf	Gaylussacia dumosa.
Huckleberry, small-leaved*	Vaccinium myrsinites.
Huckleberry, tree*	Vaccinium arboreum.
Holly, American	Ilex opaca.
Holly, deciduous (winterberry)	Ilex decidua.
Holly, myrtle-leaf*	Ilex myrtifolia.
Ironwood, swamp*	Cyrilla racemiflora.
Leucothoe	Leucothoe axillaris.
	Leucothoe racemosa.
Myrtle, wax*	Myrica cerifera.
	Myrica inodora.
Palmetto, dwarf	Sabal minor.
Palmetto, saw*	Serenoa serrulata.
Pepper vine	Ampelopsis arborea.
Pinxterbloom	Azalea nudiflora.
Poison ivy*	Rhus toxicodendron.
Scarlet balm	Clinopodium coccineum.
Smilax, dwarf	Smilax pumila.
Sumach, dwarf	Rhus copallina.
Sumach, poison	Rhus vernix.
Supplejack	Berchemia scandens.
Sweetleaf	Symplocos tinctoria.
Tea, Jersey	Ceanothus americanus.
	Ceanothus intermedius.
	Ceanothus microphyllus.
Titi*	Cliftonia monophylla.
Trumpet creeper	Bignonia radicans.
Yaupon	Ilex vomitoria.

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